ANGLER HARVEST SURVEY

KUSAWA LAKE 2006

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ANGLER HARVEST SURVEY
KUSAWA LAKE 2006
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Key Findings

- Anglers spent an estimated 4,325 hours angling on Kusawa Lake in the summer of 2006. This was 0.3 hours per hectare, higher than average for accessible large lakes.

- Angler success, as measured by the number of lake trout caught per hour of angling, was slightly above average compared to other Yukon fisheries but down from the 2001 survey.

- Anglers caught 864 lake trout and kept 427 (a 49% retention rate).

- When considering harvest and incidental mortality from catch and release, we estimate a minimum of 662 kg of lake trout was harvested. This was less than the estimated Optimal Sustainable Yield (OSY) of 891 kg, but several sources of harvest were not quantified or included.

- Harvest exceeded the optimal yield in 2001, and this survey demonstrated a decline in angler catch per unit effort, steadily increasing angler effort over the 3 surveys since 1990, and a reduction in the average age and size of lake trout harvested. Close monitoring of the recreational fishery and the lake trout population should be a priority.

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Introduction

We conduct angler harvest surveys, also called creel surveys, on a number of Yukon recreational fisheries each year. We use these surveys, together with other fish and fishery-related assessments, to find out if the harvest of fish from the lake is sustainable. Environment Yukon tries to conduct angler harvest surveys on key fisheries every 5 years or according to angler patterns and management concerns. The results of the surveys directly contribute to management decisions that make sure fisheries are sustainable over the long term.

Kusawa Lake is located in south central Yukon within the traditional territories of the Champagne and Aishihik and Carcross/Tagish First Nations (Figure 1). It is a long (72.5 km), narrow, large (142 km^2), and deep (mean depth 54 m) lake. Kusawa Lake is the headwaters of the Takhini River, a tributary to the Yukon River system. Road access is limited to the very northern part of the basin where there is a popular Yukon government campground, boat launch, and a few scattered cottages. Kusawa Lake is a popular weekend destination for Whitehorse recreationists and offers a spectacular setting for all outdoor pursuits. The area has been designated as a territorial park through the Carcross/Tagish First Nation and Kwanlin Dün First Nation land claim agreement processes and ratification.

High use and local importance make Kusawa Lake a priority for monitoring. Previous angler harvest surveys were done in 1990 and 2001.

The 2006 survey was done to:

- determine how much time anglers spent fishing (effort);
- understand the fishery's characteristics and patterns of use;
- measure the success rate of anglers;
- compare the level of harvest to the productive capacity of the lake;
- record biological information on harvested fish;
- provide anglers with information about regulations; and
- establish a fisheries management presence.

Harvest Regulations

The recreational fishery on Kusawa Lake has been managed under general catch and possession regulations since 1991. These regulations offer some protection to the larger spawning fish by permitting the retention of only one large fish of each species. The catch limit for lake trout is 3 fish per day and only one fish over 65 cm may be retained. The possession limit is 6 fish. For Arctic grayling, the catch limit is 5 fish per day and only one fish over 40 cm may be retained. The possession limit for grayling is 10 fish. For northern pike, the catch limit is 5 fish per day and only one fish over 75 cm may be retained. The possession limit is 10 fish. General catch and possession limits also apply to all other species. The regulation history for Kusawa Lake is detailed in Appendix 1.

Methods

Survey

In 1990 Environment Yukon adopted survey methodology developed by the Ontario Ministry of Natural Resources (Lester and Trippel 1985). A field worker conducts face-to-face interviews with anglers on selected sample days throughout the summer. The worker asks a standard set of questions about the social and biological aspects of the fishery. Data gathered include:

- How much time did anglers spend fishing?
- What fishing methods did anglers use?
- How did anglers fish (boat, shore, etc.)?
- Were anglers guided?
- Where were anglers from?
- What type of visitor were anglers (day users, campers, etc.)?
- What kinds of fish were anglers trying to catch?
- How many fish did anglers catch?
- How many fish did anglers release?

Any other information offered by anglers about their fishing experience is also recorded.

The field worker also collects biological data on the catch of cooperative anglers. Biological data gathered include: length (mm), mass (g), sex, maturity, scales or an otolith (a small bone from the fish's head) for aging, and stomachs for content analysis in the lab. Any other information about general health and

condition of the fish is recorded by the field worker (e.g., abnormalities, disease, lesions).

The field worker subjectively assesses the weather's effect on fishing over the entire sample day (no possible adverse effect, possible adverse effect, definite adverse effect).

The timing of the survey depends on management objectives, key species, and the nature of the fishery. It typically runs from ice out in the spring until either just after Labour Day or the end of September. The goal is to do sampling on at least 20% of the total survey days. The survey is subdivided into several seasonal periods (usually 3 or 4), which are further divided into weekends and weekdays. Each period has a minimum number of sample days, with a higher weighting and increased number of sample days for those periods with higher projected angler use.

Sample days are 14 hours long, 8:00AM to 10:00PM. On sample days, the field worker interviews all willing anglers. The field worker also records anglers who are observed but not interviewed.

Analysis

When the survey is finished, we enter the data into the computer program CREESYS (1985) developed by the Ontario Ministry of Natural Resources. The data are analyzed using standard statistical methods. We determine the age of sampled fish by counting growth rings on the otolith. Diet is determined by examining the stomach contents.

Lake Productivity

The productivity of a lake determines the amount of fish produced annually and can guide how much harvest can be sustained. Estimates of lake productivity are calculated using average lake depth, the concentration of total dissolved solids, and the average annual air temperature at the lake. Ryder's morphoedaphic index (1974) is used and incorporated into Schlesinger and Regier's equation (1982) for calculation of maximum sustained yield (MSY) for all species. Calculation of MSY for lake trout assumes a biomass of 30% lake trout; where appropriate this may be replaced by the most recent survey data. Following O'Connor (1982) and others, 15% of MSY provides an "optimum" sustained yield (OSY), which maintains high quality fisheries on light to moderately fished lakes.

2006 Kusawa Lake Survey

The survey began May 28 (ice out) and concluded September 30, 2006.

We used an access survey method. The field worker was stationed at the Kusawa Lake campground and boat launch (Figure 1) for the entire sample

day. The worker interviewed angling parties at the end of their fishing trips. All angling activity originates from this area as it is the only point of access to Kusawa Lake.

The survey period was partitioned into 6 time periods, weekends and weekdays in June, July and August/September. Of the 126 day survey period, 45 days were sampled, resulting in a sampling effort of 36%.

We divided data analysis into two parts. In the first part, we combined data across all 6 time periods. In the second part, we compared results between time periods (see Appendix 2).

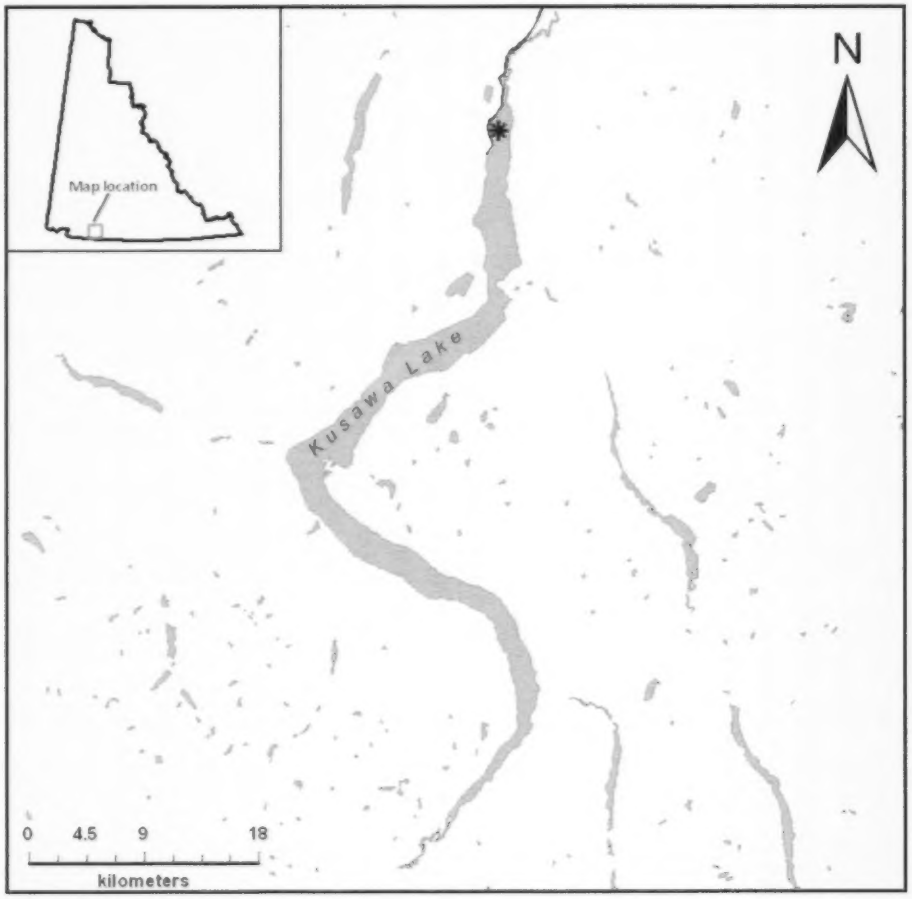

Figure 1. Kusawa Lake, showing location of 2006 Angler Harvest Survey (*).

Results of the 2006 Survey

Effort

We estimated a total of 4,325 hours of angler effort were expended on Kusawa Lake over the 2006 survey period. This was 0.3 hours per hectare and higher than average for accessible large lakes. On Kusawa Lake 1,521 anglers fished for an average of 34.3 angler hours per day over the entire survey and an average of 2.8 hours per angler.

Methods of Access

Most anglers fished from motorboats (Table 1), and a smaller proportion fished from shore. A few anglers fished from canoes.

Table 1. Access methods, Kusawa Lake 2006.

Method of Fishing	Percent of Parties
Canoe	2%
Rowboat	
Motorboat	85%
Shore	13%
Other	

Fishing Methods

Trolling was by far the most popular method of fishing, followed by spin casting and then combinations of methods (Table 2).

Table 2. Fishing methods, Kusawa Lake 2006.

Method of Fishing	Percent of Parties
Still	
Jig	
Drift	
Troll	83%
Spin cast	11%
Fly cast	
Other or combination	5%

Guided Anglers

Very few anglers were formally guided (Table 3). Many fishing parties did have non-residents along with them, but were not formally guided.

Table 3. Guided anglers, Kusawa Lake 2006.

Anglers	Percent of Parties
Yes	1%
No	99%

Angler Origin

Whitehorse anglers were by far the most frequent fishers (Table 4). There was a small percentage of fishers from other areas of Yukon, a few Canadian and American anglers, and a small number of Europeans.

Table 4. Angler origin, Kusawa Lake 2006.

Angler Origin	Percent of Parties
Local	<1%
Whitehorse	92%
Yukon	3%
Canada	2%
U.S.	2%
Other	1%

Visitor Type

Most anglers were camped in the government campground at the lake (Table 5). There were also day users and a few anglers who camped on Crown land along the lake shore.

Table 5. Angler visitor type, Kusawa Lake 2006.

User Type	Percent of Parties
Day Users	21%
Camper – Territorial campground	74%
Camper – Crown land	5%
Camper – Private campground	

Weather

The field worker's subjective assessment of weather effects on angling activity over entire sample day indicates that weather likely had some adverse effects on angling activity in 2006 (Table 6). This effect was primarily due to high winds, rain, and/or cold temperatures.

Table 6. Sample day weather, Kusawa Lake 2006.

Did Weather Affect Angling?	Percent of Parties
No possible adverse effect	36%
Possible adverse effect	42%
Definite adverse effect	22%

Targeted Species

Anglers targeting a particular species were more successful in catching the target species than those anglers that were fishing for any and all fish (Table 7). This was particularly true for Arctic grayling where the 6% of anglers that were targeting Arctic grayling were responsible for 86% of the catch and 67% of the harvest. Eighty-six percent of anglers were targeting lake trout, and they were responsible for 94% of the catch and 98% of the lake trout harvest.

Table 7. Catch and harvest by anglers targeting specific species, Kusawa Lake 2006.

Species	Percent of Parties	Percent of Total Catch	Percent of Total Harvest
Lake trout	86%	94%	98%
Arctic grayling	6%	86%	67%

Catch and Harvest

Lake trout was by far the most caught and harvested species with a moderate retention rate (Table 8). Arctic grayling were only angled for sporadically with a small number being caught.

Table 8. Angler catch and harvest, Kusawa Lake 2006.

Species	# Caught	# Kept	Retention Rate
Lake trout	864	427	49%
Arctic grayling	71	33	47%

Estimated angler success rates, calculated over the entire survey as numbers of fish caught per hour of angling effort (CPUE), is presented for all anglers (regardless of target species) and species anglers (those targeting a specific species) in Table 9. As expected, anglers targeting a specific species were more successful than general anglers, particularly for Arctic grayling, as they were targeted in prime habitats in which they aggregate, such as creek inflows. Almost all anglers targeted lake trout so results are similar for both groups.

Table 9. Estimated catch per unit of effort (fish/hour), Kusawa Lake 2006.

Species	All Anglers CPUE	Species Anglers CPUE
Lake trout	0.20	0.21
Arctic grayling	0.02	0.16

2006 Biological Data

We sampled 154 lake trout for biological data. Mean fork length was 477 mm, mean weight was 1,314 g, and mean condition factor was 1.21. This is a very good condition factor (relationship between length and weight) for lake trout in Yukon and indicates "fat" fish. The sex ratio in the sample was nearly even with 1.09 females per male. Lake trout were harvested across a range of size classes from 311 to 847 mm, although sizes over 620 mm fork length (650 mm total length) may be under-represented in the sample as regulation only allows the retention of one fish over this size (Figure 2).

Ages are available from 109 of the sampled lake trout. Average age was 13 years, ranging from 5 to 31 years (Figure 3). Note that very young fish (less than 5 years) are not vulnerable to angling gear and regulation limits the harvest of larger fish. These portions of the population are therefore under represented in the sample.

Diet analysis was conducted on 142 lake trout stomachs. Of these, one was empty and the remaining 141 averaged 61.5% full. Fish were the most common diet item identified comprising 56.4% of the lake trout diet (Table 10).

Eight Arctic grayling were sampled. The data are not reported here because of the small sample size, but are available upon request from Environment Yukon.

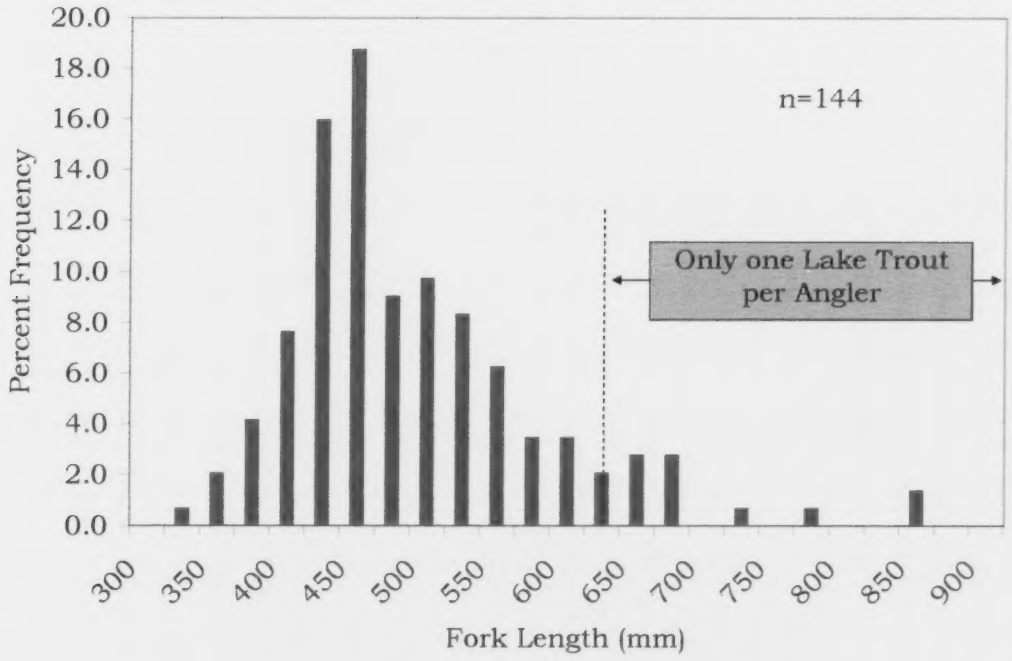

Figure 2. Lengths of lake trout harvested by anglers, Kusawa Lake 2006.

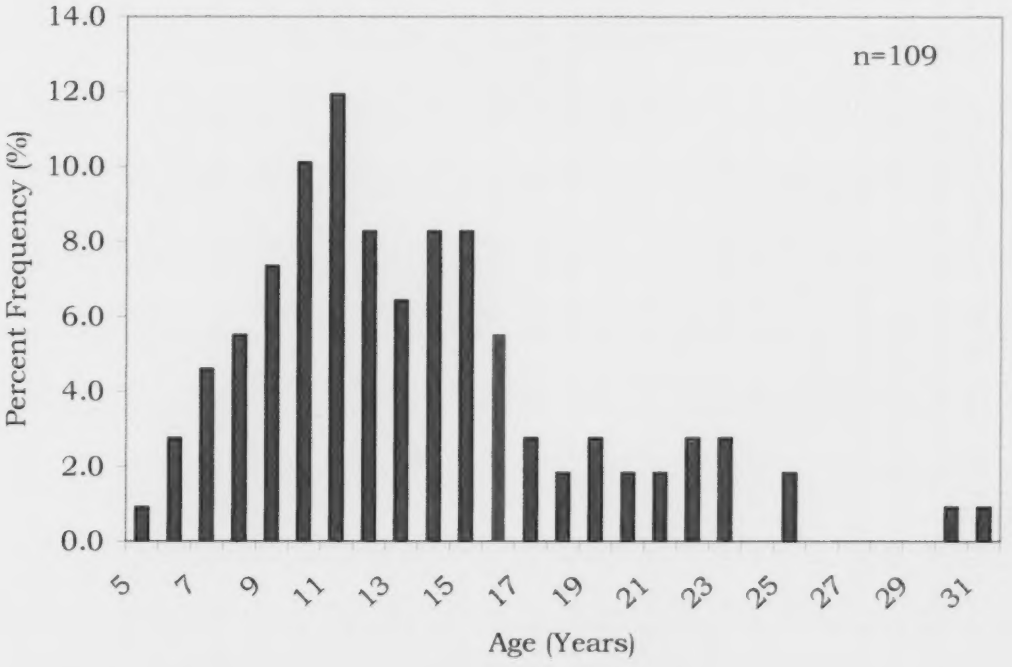

Figure 3. Ages of lake trout harvested by anglers, Kusawa Lake 2006.

Table 10. Sampled lake trout stomach contents, Kusawa Lake 2006.

Stomach Contents	Percent Volume
Unidentified fish	56%
Non-biting midges	15%
Unidentified invertebrates	13%
Caddisflies	8%
Beetles	5%
Unidentified vegetation	1%
Ants	1%
Wasps, bees	<1%
Unknown	<1%
Orb snails	<1%
Flies (two-winged)	<1%
Pond snails	<1%
Water fleas	<1%
Bugs	<1%
Slimy sculpin	<1%
Clams, mussels	<1%
Burbot	<1%
Stoneflies	<1%
Northern pike	<1%
Scuds, sideswimmers	<1%
Dragonflies, damselflies	<1%

Comparison with Previous Surveys

Angler harvest surveys were previously completed on Kusawa Lake in 1990 and 2001. The 2006 survey was of similar methodology and design and is directly comparable with these surveys. The only difference is that the 1990 survey ended September 4, while the 2001 and 2006 surveys continued to September 30.

Effort

Estimated summer open water angler effort has been increasing steadily over the surveys (Table 11).

Table 11. Total estimated angler hours, Kusawa Lake 2006, compared to 1990 and 2001.

	2006	2001	1990
Hours	4,325	3,603	2,058

Methods of Access

Methods of access were dominated by motorboats in all surveys (Table 12). There was a slight decline in motorboats in 2006 and a corresponding increase in shore anglers.

Table 12. Fishing method of access (percent of parties) Kusawa Lake 2006, compared to 1990 and 2001.

Access Method	2006	2001	1990
Canoe	2%	2%	
Rowboat		<1%	
Motorboat	85%	95%	95%
Shore	13%	2%	5%
Other		<1%	

Fishing Methods

Fishing methods were quite similar between surveys (Table 13). Data on fishing methods are not available from the 1990 survey, but from Table 12 we know that 95% of anglers used motorboats in 1990, suggesting that trolling was also the most dominant angling method in 1990.

Table 13. Fishing methods (percent of parties) Kusawa Lake 2006, compared to 1990 and 2001.

Method of Fishing	2006	2001	1990
Still			
Jig			
Drift	<1%	1%	
Troll	83%	87%	N/A
Spin cast	11%	4%	
Fly cast	<1%	1%	
Other or combination	5%	7%	

Guided Anglers

Formally guided parties comprised 1% of anglers in 2006 and less than 1% in 2002 (Table 14). These data are not available from 1990.

Table 14. Guided anglers (percent of parties) Kusawa Lake 2006, compared to 1990 and 2001.

Guided Anglers	2006	2001	1990
Yes	1%	<1%	n/a
No	99%	99%	n/a

Angler Origin

The origin of anglers has not changed since 1990; Whitehorse anglers are by far the heaviest users (Table 15).

Table 15. Origin of anglers (percent of parties) Kusawa Lake 2006, compared to 1990 and 2001.

Origin	2006	2001	1990
Local	<1%	<1%	
Whitehorse	92%	93%	93%
Yukon	3%	<1%	
Canada	2%	4%	6%
U.S.	2%	<1%	1%
Other (usually Europeans)	1%	1%	

Visitor Type

Visitor type showed similar results between 2006 and 2001 with government campground users being dominant (Table 16). These data are not available from 1990.

Table 16. Visitor type (percent of parties) Kusawa Lake 2006, compared to 1990 and 2001.

User Type	2006	2001	1990
Day users	21%	19%	n/a
Campers - government campground	74%	68%	n/a
Campers - crown land	5%	13%	n/a

Weather

The field worker's subjective assessment of weather effects on angling activity indicates that weather was slightly better in 2001 than in 2006 (Table 17). These data are not available from 1990.

Table 17. Weather effects on angling activity (percent of parties) Kusawa Lake 2006, compared to 2001.

Did Weather Affect Angling?	2006	2001	1990
No possible adverse effect	36%	32%	n/a
Possible adverse effect	42%	59%	n/a
Definite adverse effect	22%	10%	n/a

Catch and Harvest

The number of lake trout caught in 2006 was down slightly from 2001 estimates, although still well above 1990 estimates (Table 18). The number of lake trout harvested has been quite stable over the years. Even the lower catch in 1990 resulted in a similar harvest level because the retention rate was higher.

The catch of Arctic grayling was down slightly in 2006 compared to 2001 surveys (Table 18) but harvest was up because more Arctic grayling were retained.

Northern pike were observed only in the survey in 2001.

Table 18. Estimated number of fish caught, fish kept and the retention rate, Kusawa Lake 2006, compared to 1990 and 2001.

Species	Retention	2006	2001	1990
Lake trout	Caught	864	1,091	474
	Kept	427	504	409
	Released	437	587	65
	% Kept	49	46	86
Arctic grayling	Caught	71	89	6
	Kept	33	14	3
	Released	38	75	3
	% Kept	46	16	50
Northern pike	Caught		5	
	Kept		0	
	Released		5	
	% Kept		0	

Estimated CPUE (number of fish caught per angler hour) over the entire survey can reflect changes in the fishery because it incorporates effort and catch. Dramatic decreases in CPUE for a particular species could indicate problems in terms of the health or status of the fish species in question. However, relying on CPUE of anglers alone is not recommended – see the section entitled "Invisible Collapse" in the *Status of Yukon Fisheries 2010* (Environment Yukon 2010) – anglers are very good at finding fish even when the population is in decline.

Lake trout CPUE has declined since 2001 to slightly below 1990 results (Table 19). Results for 2006 were still above Yukon averages for lakes surveyed to date (all lakes average of 0.13).

Table 19. Estimated catch per unit of effort (fish/hour), Kusawa Lake 2006, compared to 1990 and 2001.

Species	2006	2001	1990
Lake trout	0.20	0.30	0.23
Arctic grayling	0.02	0.03	<0.01
Northern pike		<0.01	

The CPUE data for species other than lake trout should be treated with caution; usually these species receive little fishing effort, and so these estimates are imprecise.

Biological data

Lake trout harvested in 2006 by anglers were most commonly 11 years old; the average age was 13.4 (n = 109). The average lake trout harvested was younger than in 2001, when the modal age was 14 and the average age was 15.8 (ANOVA, P = 0.01, F = 6.64). Lake trout harvested in 2006 were also smaller than in 2001, but the length of a lake trout at a given age does not appear to have changed (data not shown). Fishing regulations have not changed since 1991, so all other things being equal, the fish being harvested by anglers should represent the underlying population of fish in the lake. Given this, a trend of smaller and younger fish being harvested may reflect a similar trend in the lake trout population. Another possibility is that angler behaviour has changed such that the larger (and older) fish are released more often than smaller (and younger) fish.

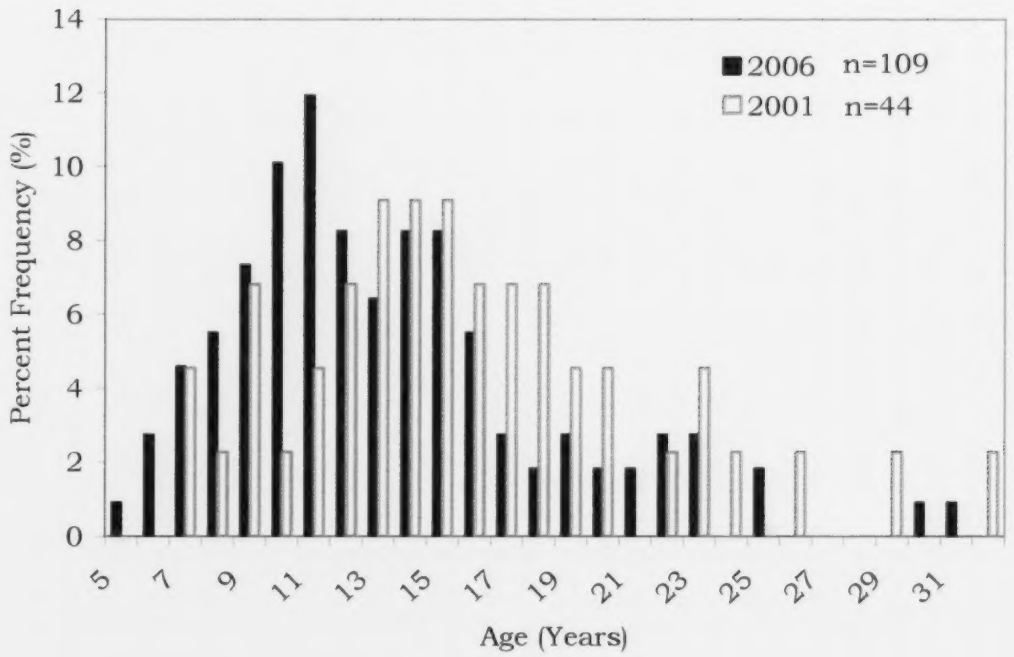

Figure 4. Age of lake trout harvested from Kusawa Lake in 2001 and 2006.

Fishery Sustainability

We estimate that Kusawa Lake could sustain a total annual lake trout harvest of about 900 kg (total dissolved solids: 40 mg/L, mean annual air temperature: -1.1 °C, mean depth: 54 m; see Methods - *Lake Productivity*). Predictions of sustainable yield are uncertain, so we aim to minimize risk and maintain fishery quality by using conservative estimates.

Anglers harvested 427 lake trout from Kusawa Lake over the summer (Table 20). Total fishing mortality includes the unintentional mortality of any released fish. Catch and release, when done properly, has a minimal impact on fish that are released; lake trout survival rates range from 93% for lightly handled fish to 76% for deep-hooked fish (YFWMB 1998). We used an average of 85% survival, which for the 437 lake trout released in 2006, results in an additional mortality of 66 fish for a total of 494 fish. Based on the average size of harvested fish, the weight of total lake trout mortality in the recreational fishery was 662 kg. This is considered the minimum harvest; additional harvest from the open water fishery outside of the period of this survey, from the ice fishery, and from the First Nations subsistence fishery is not accounted for here. No information is currently available on these fisheries.

Table 20. Estimated summer lake trout harvest by anglers Kusawa Lake 2006, compared to 1990 and 2001.

Lake Trout Harvested	2006	2001	1990
Lake Trout Harvested	427	504	409
Lake Trout Released	437	587	65
Catch and Release Mortality (15%)	66	88	10
Total Harvest & Mortality	494	592	419
Mean Weight (kg)	1.34	1.76	1.27
Total Harvest & Mortality (kg)	662	1042	532

Fishing harvest and mortality in 2006 (662 kg) was lower than the OSY (~900 kg) as estimated from the potential productivity of the lake. If all other sources of harvest (ice fishery, open water fishery outside of the survey period, and First Nations subsistence harvest) are less than 238 kg, then the harvest of lake trout from Kusawa Lake is sustainable. In 2001, harvest exceeded the optimal yield. In that year the average size of lake trout was bigger and so the total biomass removed was much higher. Based on these findings, we expect that OSY may be exceeded from time to time on Kusawa Lake. Sustained harvests above OSY may deplete the stock and could result in declining catches and poorer quality fishing.

Several trends in the data suggest that the Kusawa Lake fishery merits close monitoring:

- the number of hours that anglers spend fishing on Kusawa Lake has increased in each consecutive survey and Kusawa is one of the 5 most heavily fished lakes in Yukon;
- the CPUE for lake trout decreased substantially since 2001 (though only marginally since 1990);
- the average fish harvested in 2006 was smaller and younger than in 2001; and
- OSY is likely exceeded from time to time.

Individually, a single factor may not be that worrisome, but taken together, these trends could suggest negative changes in the population.

We recommend that a survey of the lake trout population be carried out on Kusawa Lake in the near future and that a priority be put on carrying out follow-up angler harvest surveys. We also recommend that future surveys attempt to quantify all other harvests that are not documented during the survey for a more complete understanding.

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APPENDIX 1. Kusawa Lake angling regulations, 1989 to 2006.

Year	Species	Catch limit	Possession limit	Size restrictions
1989/90*			General Regulations	
	Lake trout	3	6	Only one fish over 80 cm
	Arctic grayling	5	10	none
	Northern pike	5	10	none
	Whitefish	5	10	none
1991/92			General Regulations	
	Lake trout	3	6	Only one fish over 65 cm
	Arctic grayling	5	10	Only one fish over 40 cm
	Northern pike	5	10	Only one fish over 75 cm
	Whitefish	5	10	none

* Yukon Government obtained responsibility for freshwater fisheries management from the Federal Government in 1989

APPENDIX 2. 2006 Kusawa Lake angler harvest survey results: Comparisons between periods

Effort

Mean daily angler effort on weekends was high throughout the summer, but very high in July (Figure 2.1). Weekday effort was much lower than weekend effort in all periods, lowest in May/June, also peaking in July.

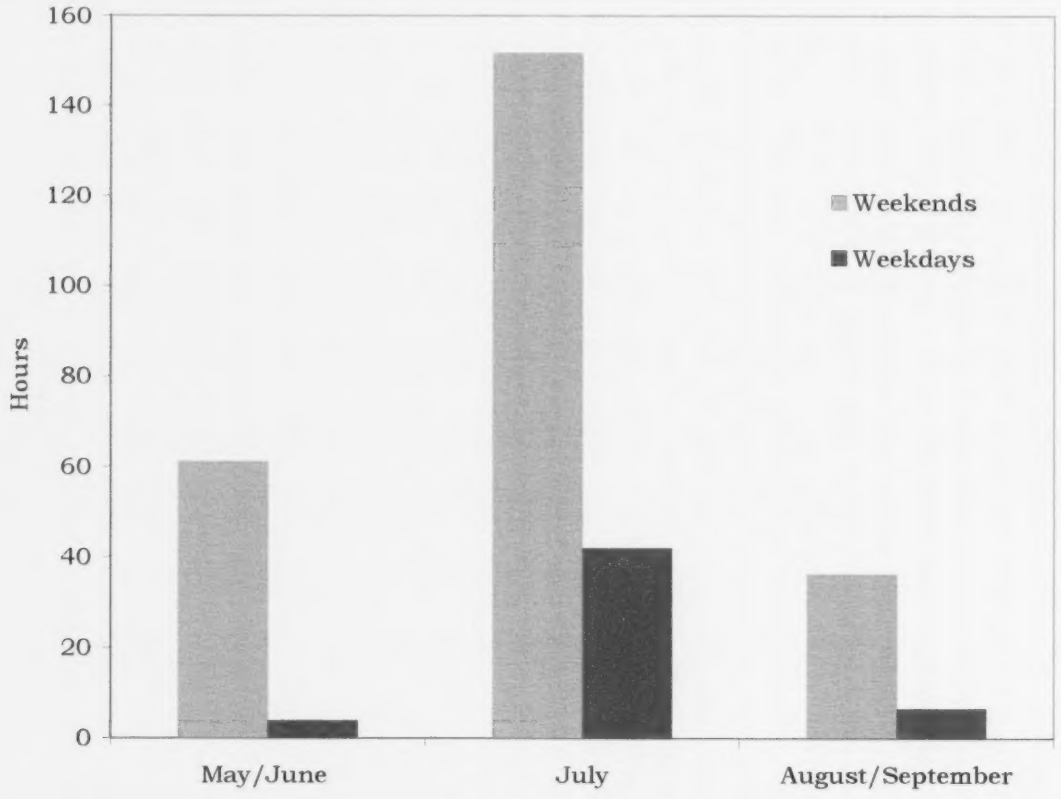

Figure 2.1. Estimated angler effort per day, Kusawa Lake 2006.

Fishing Methods

Fishing methods were relatively consistent across all periods other than no anglers using combinations of methods on July weekends or both August/September periods.

Guided Anglers

Guided parties were not observed on either July period, and were as common on weekends as weekdays in other periods.

Angler Origin

Origin of anglers was dominated by Whitehorse anglers in all periods. Yukon and non-resident Canadians were lightly scattered in most periods, American anglers were only observed on July weekends and August/September weekdays, Europeans were only observed on May/June weekends and August/September weekdays, while local anglers were only observed on July weekends.

Visitor Type

Visitor type was fairly consistent over the summer with an even ratio of day users to government campground users. Crown land campers were almost entirely present on weekends in all periods.

Weather

The influence of weather on angling activity was not analyzed by period.

Catch

Lake trout CPUE was variable over the summer. It was slowest in the spring periods with July weekdays showed the highest results, likely due to more experienced anglers fishing during the week (Table 2.1) and the angling remained good throughout the fall periods. Arctic grayling were mostly angled for off of shore near the campground and CPUE was very low in most periods, highest on August/September weekdays.

Catch per unit effort patterns for lake trout were not entirely consistent with typical Yukon summer patterns. Success is usually highest in the spring following ice out and then drops as water temperatures warm. Often there are fall increases related to onset of spawning movements and cooling water temperatures. High spring CPUE was noticeably absent.

Table 2.1. Estimated catch per unit of effort (fish/hour) by period, Kusawa Lake 2006.

Period	Lake Trout	Arctic Grayling
May/June weekends	0.12	0.01
May/June weekdays	0.13	0.01
July weekends	0.17	0.02
July weekdays	0.29	0.01
August/September weekends	0.25	
August/September weekdays	0.21	0.08